Spiral Innovation: Building an Outsourcing Ecosystem for Science

Kate Keahey
keahey@mcs.anl.gov
Argonne National Laboratory
Computation Institute, University of Chicago

Horseless Carriage: Story of an Innovation

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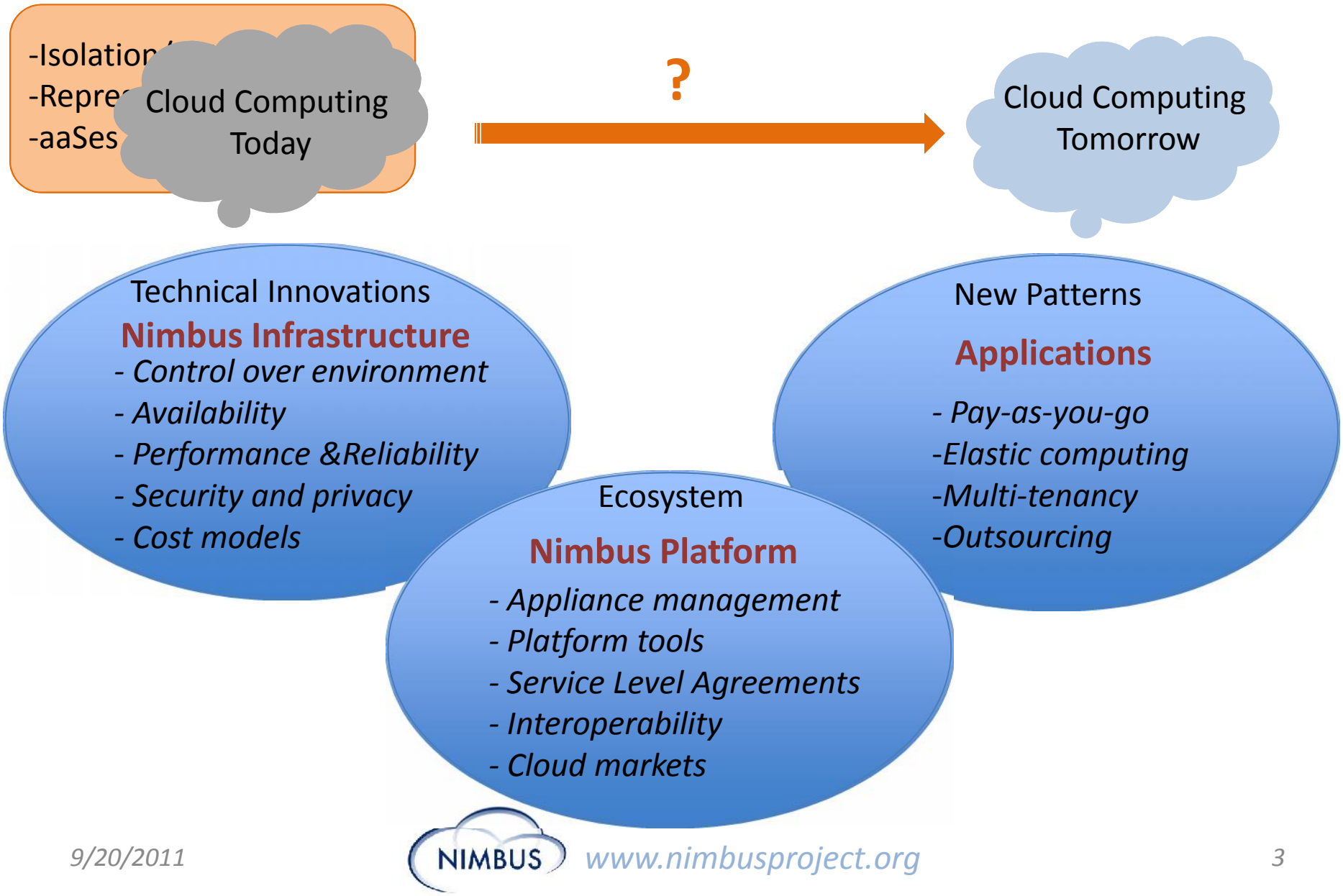
Technical Innovations

New Patterns

Ecosystem

The Cloud Computing Innovation



Nimbus Components

High-quality, extensible, customizable,
open source implementation

Nimbus Platform

Context Broker | Cloudinit.d | Elastic Scaling Tools

Enable users to use IaaS clouds

Nimbus Infrastructure

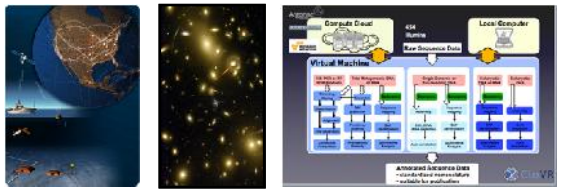
Workspace Service | Cumulus

Enable providers to build IaaS clouds

Enable developers to extend, experiment and customize

On the Nimbus Team…

Do whatever it takes to enable
Infrastructure clouds for science



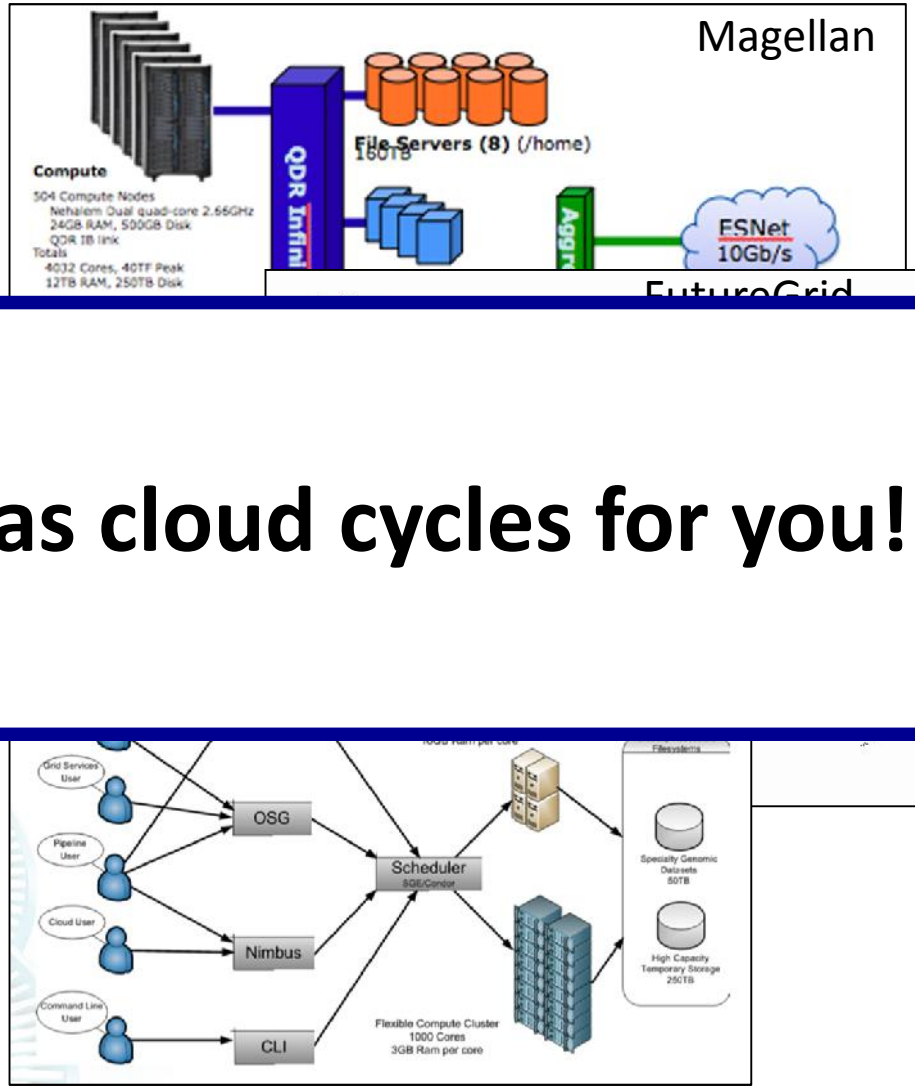
Applications and Patterns

?

How do we turn a “bad cloud”
Into a “good cloud”?

Scientific Cloud Resources

- Science Clouds
  - UC, UFL, Wispy@Purdue
  - ~300 cores
- Magellan
  - DOE cloud @ ANL &LBNL
- F
- M
  - ~1200-1500 cores
- Outside of US:
  - WestGrid, Grid'5000

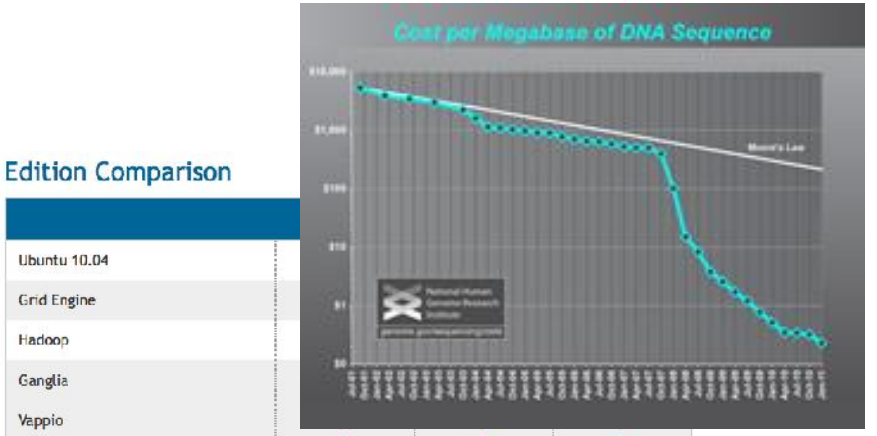


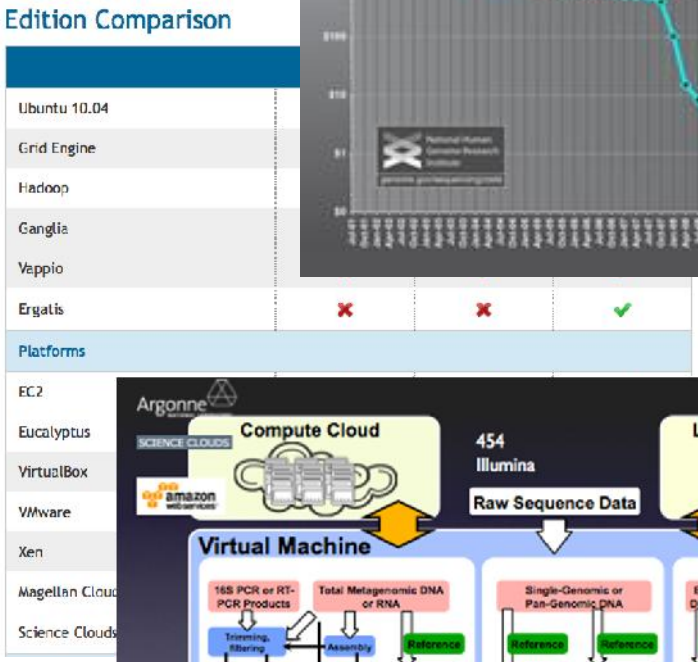
Future Grid

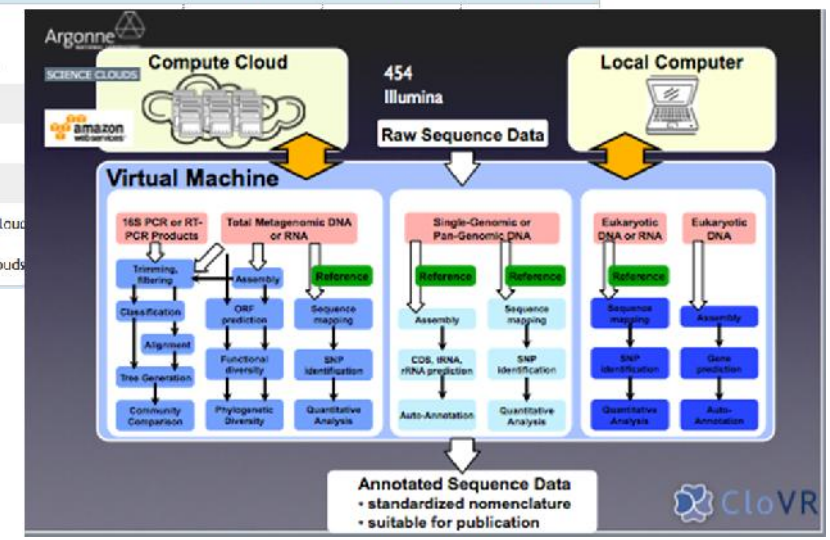
has cloud cycles for you!

Sam Angiuoli
Institute for Genome Sciences
University of Maryland School of Medicine

- The emergent need for processing
- A virtual appliance for automated and portable sequence analysis
- Approach:
  - Running on user's desktop
  - Then running on Nimbus Science Clouds, Magellan and EC2
  - A platform for building appliances representing push-button pipelines
- Impact
  - From desktop to cloud
  - http://clovr.org





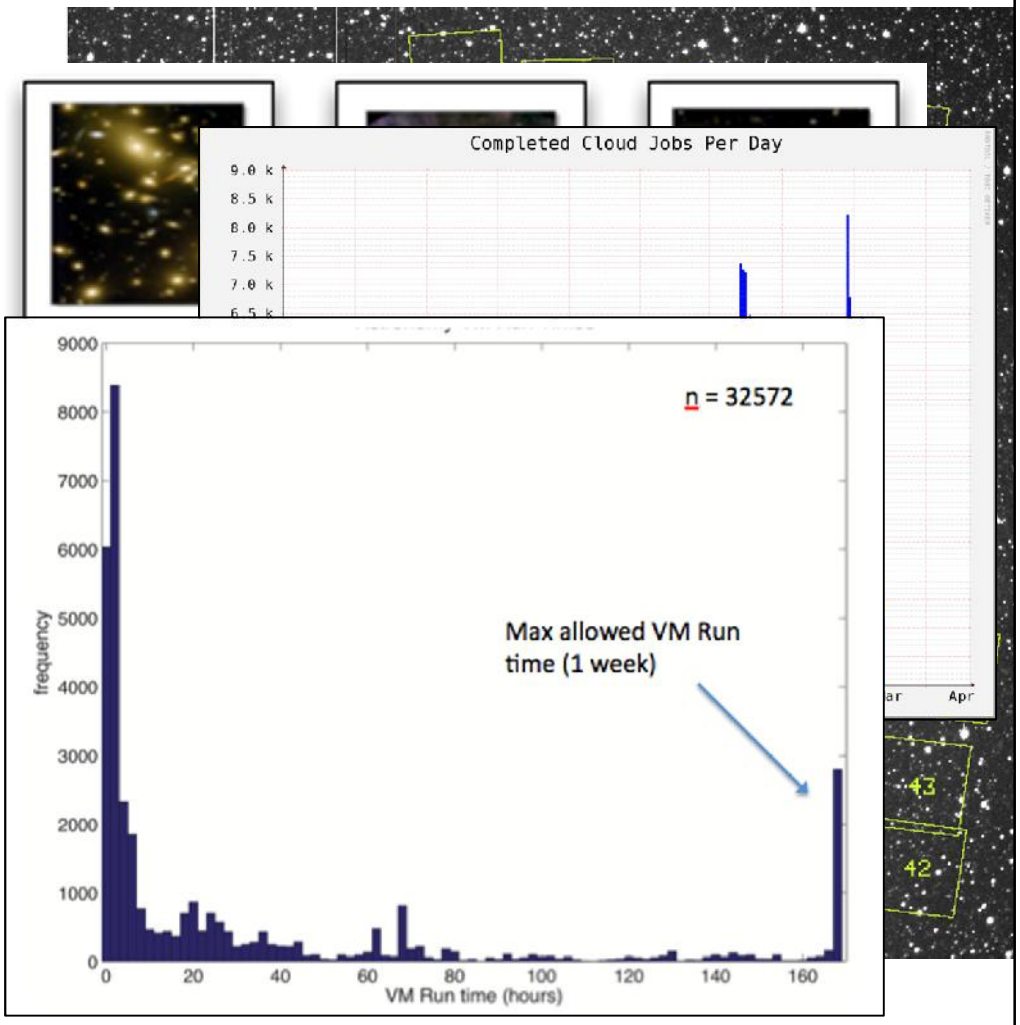


CANFAR
Canadian Advanced Network for Astronomical Research

University of Victoria NRC·CNRC

Work by the UVIC team

- Detailed analysis of data from the MACHO experiment Dark Matter search
- Provide infrastructure for six observational astronomy survey projects
- Approach:
  - Running on a Nimbus cloud on WestGrid
  - Appliance creation and management
  - Dynamic Condor pool for astronomy
- Status:
  - In production operation since July 2010

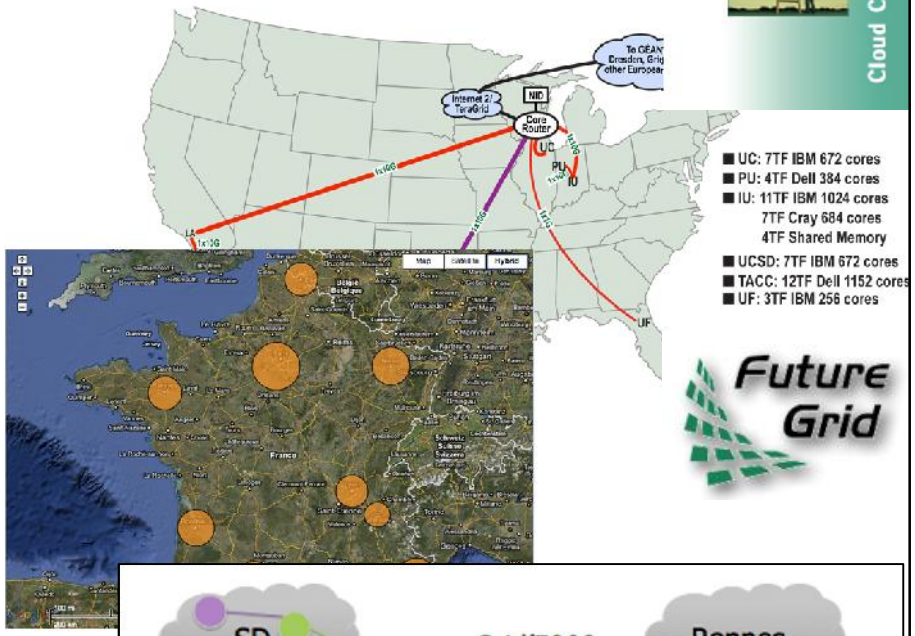


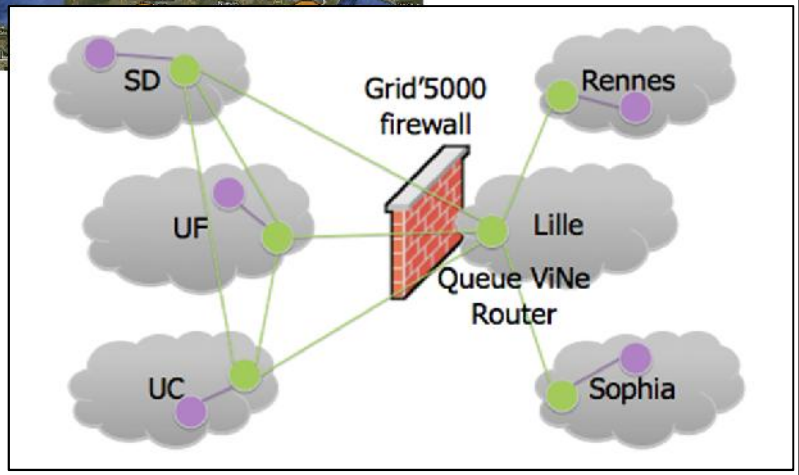
Sky Computing

Work by Pierre Riteau et al, University of Rennes 1

- Sky Computing = a Federation of Clouds
- Approach:
  - Combine resources obtained in multiple Nimbus clouds in FutureGrid and Grid' 5000
  - Combine Context Broker, ViNe, fast image deployment
  - Deployed a virtual cluster of over 1000 cores on Grid5000 and FutureGrid – largest ever of this type
- Grid'5000 Large Scale Deployment Challenge award
- Demonstrated at OGF 29 06/10
- TeraGrid '10 poster
- More at: *www.isgtw.org/?pid=1002832*

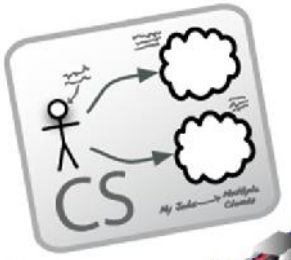
"Sky Computing"
IEEE Internet Computing, September 2009





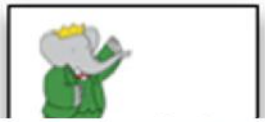
BaBar

Canadian Efforts



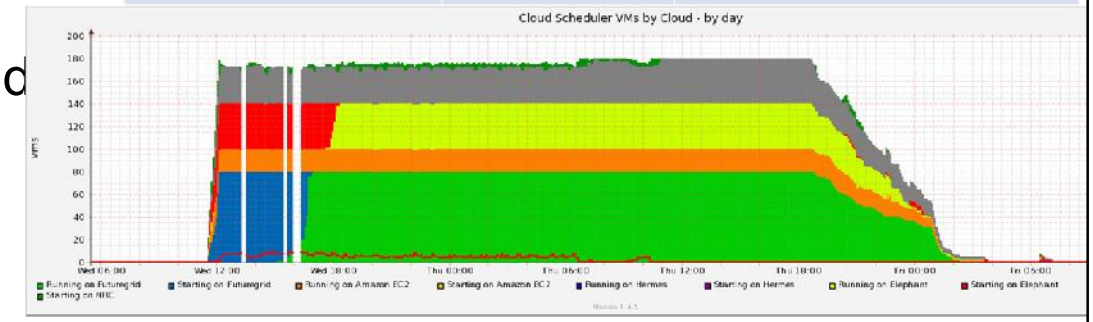
University of Victoria NRC·CNRC

Work by the UVIC team



- BarBar Experiment at SLAC in Stanford, CA
- Using clouds to simulate electron-positron collisions in their detector
- Exploring virtualization as a vehicle for data preservation
- Approach:
  - Appliance preparation and management
  - Distributed Nimbus cloud
  - Cloud Scheduler
- Running production BaBar workloads

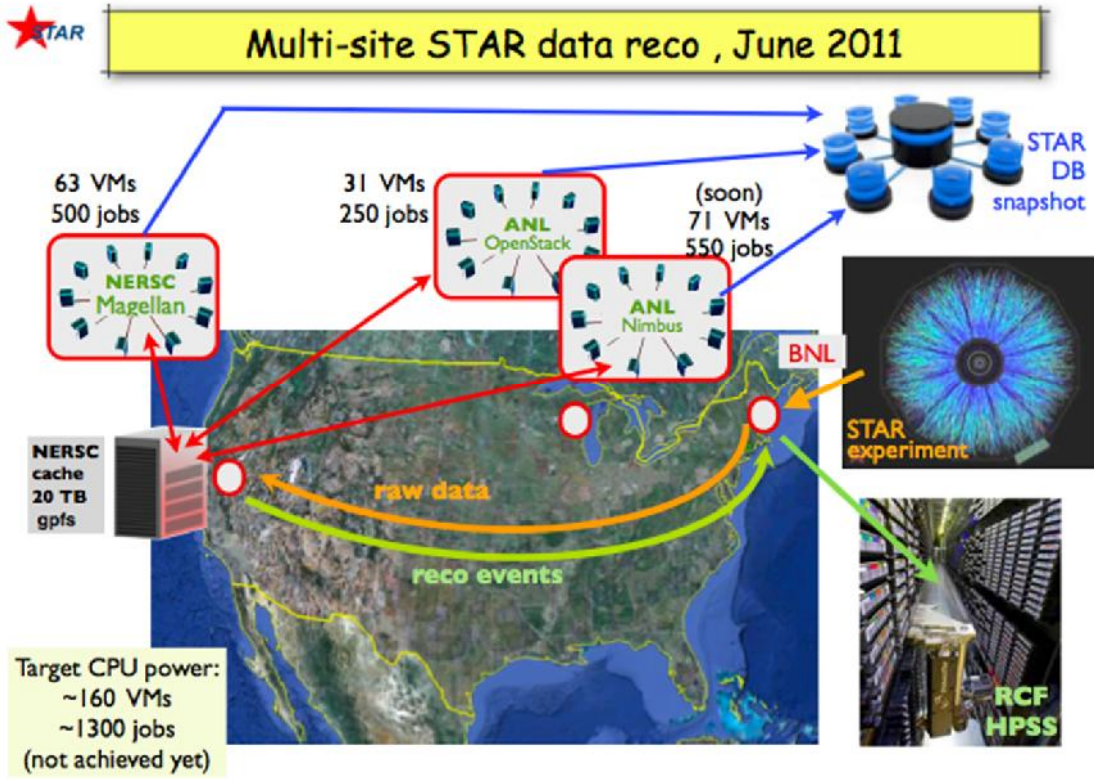
Resource	Cores	Notes
FutureGrid @Argonne Lab	100 Cores Allocated	Resources allocation to support BaBar
Elephant Cluster @UVic	88 Cores	Experimental cloud cluster hosts (xrootd for cloud)
NRC Cloud in Ottawa	68 Cores	Hosts VM image repository (repoman)
Amazon EC2	Proportional to $	Grant funding from Amazon
Hermes Cluster @Uvic	Variable (280 max)	Occasional Backfill access

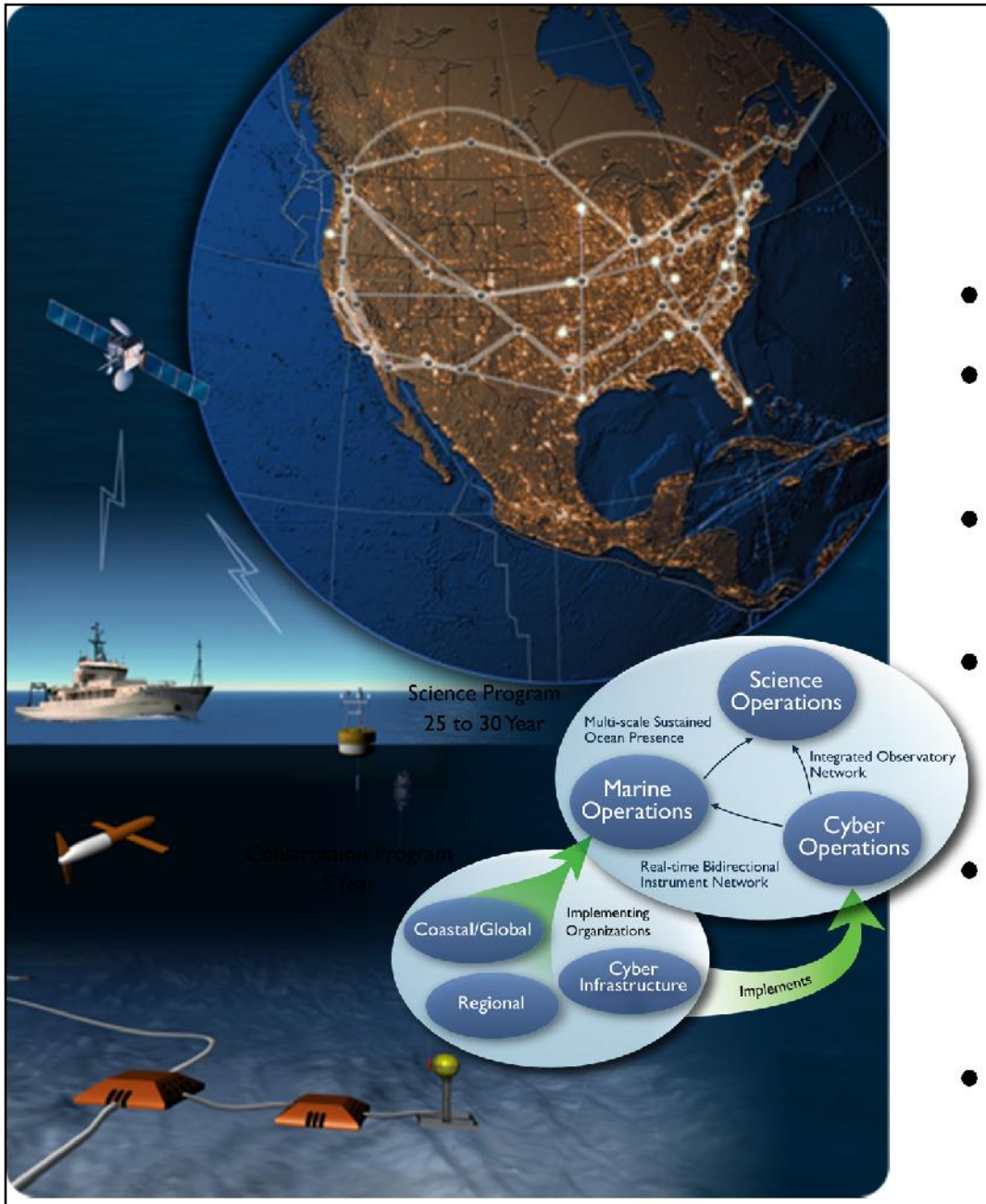


STAR

- What makes a proton spin?
- Typical timelines:
  - 5 months of data collection, followed by…
  - 10 months for detector calibration, reconstruction and analysis

- Benefits of running in the cloud:
  - Reducing "time to science" (by ~ 6 months)
  - Near real-time processing



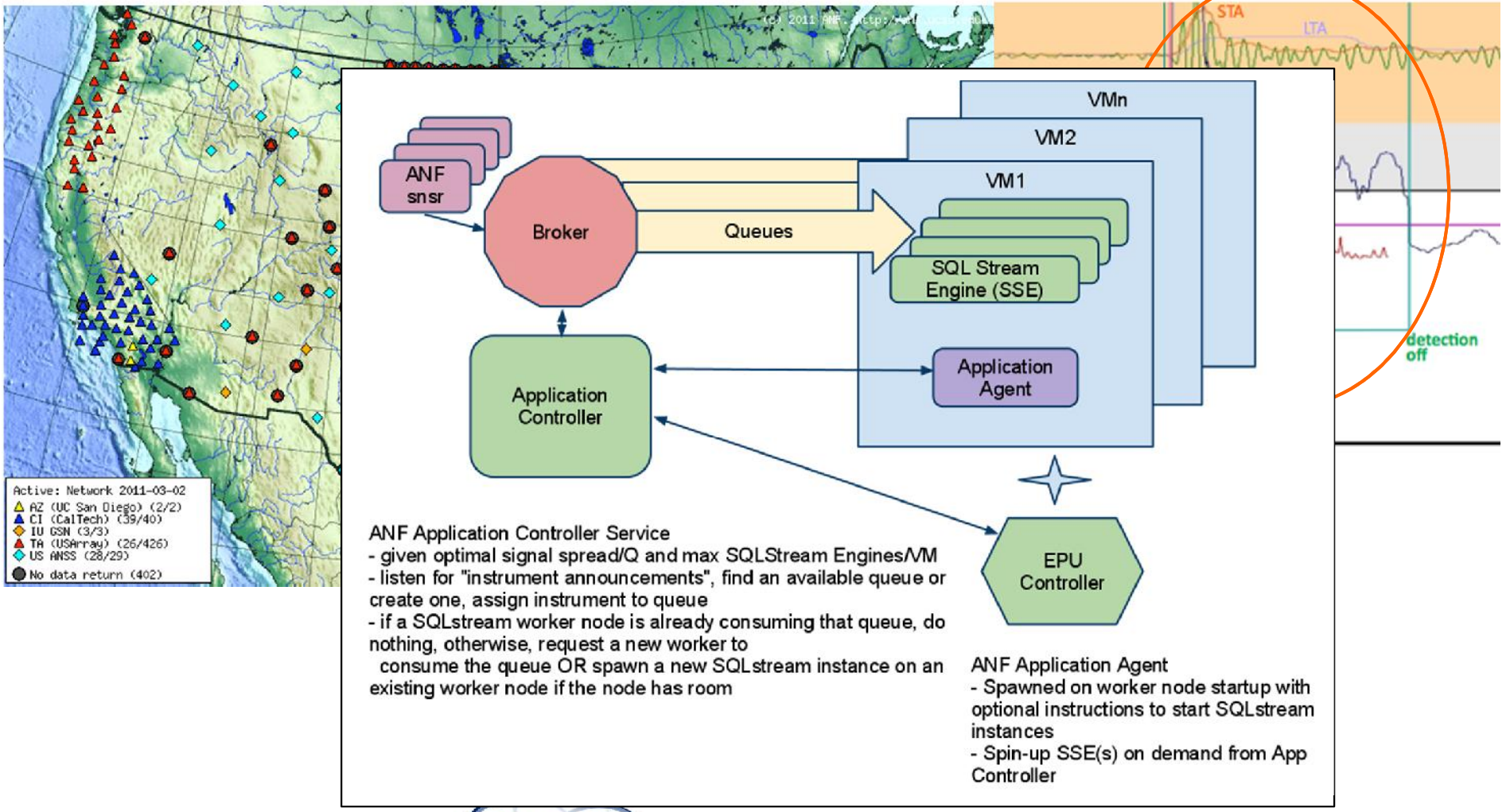


OCEAN OBSERVATORIES INITIATIVE

- Observatory Science
- Scalable, sensor driven processing
- Highly Available (HA) services
- Governance framework and policies in elastic environment
- From regional Nimbus clouds to commercial clouds
- Provide a deployment foundation for OOI CI

Array Network Facility (ANF)

Using elastic processing to operate on seismic data



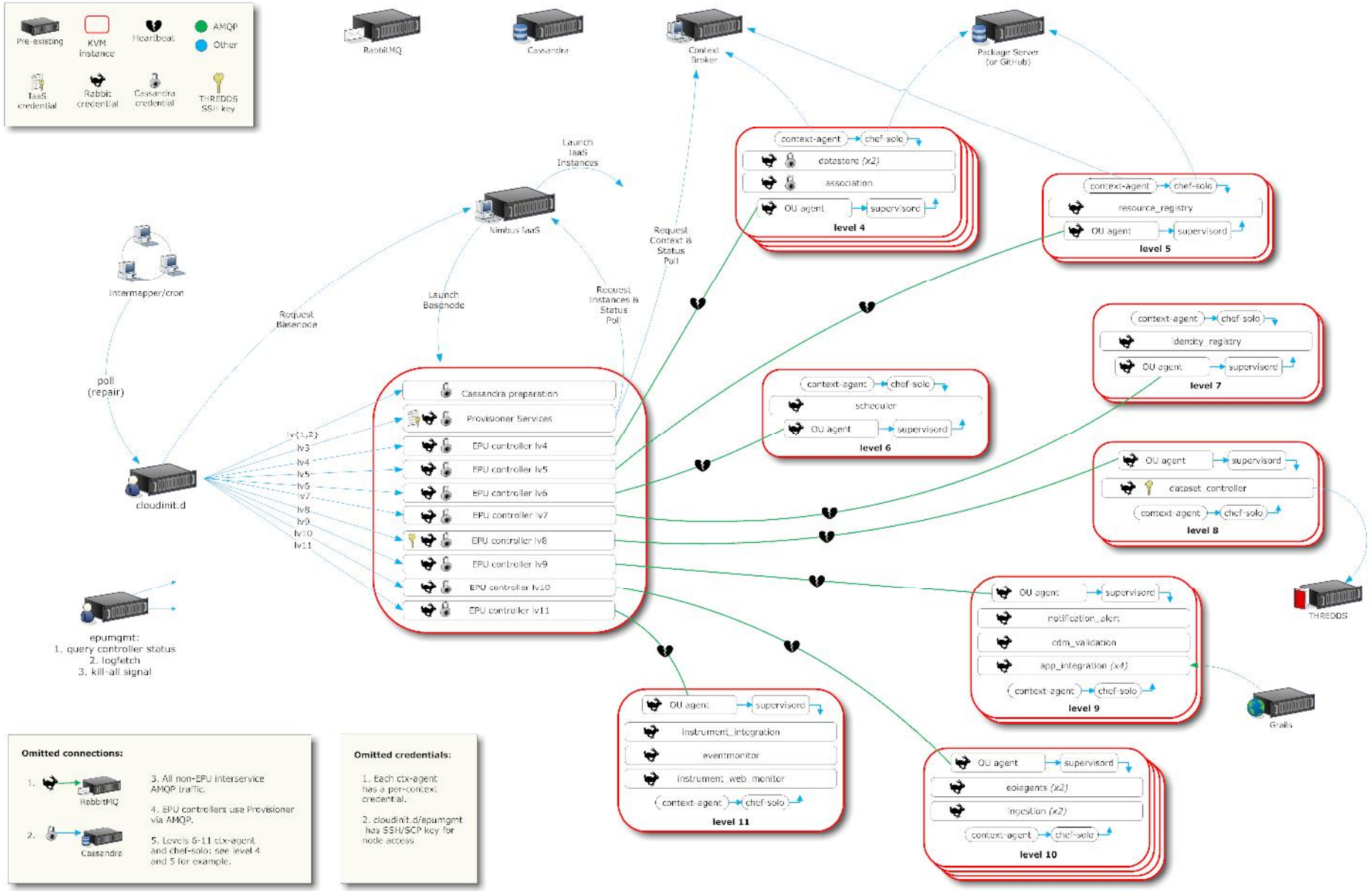
New Patterns

- On-demand processing
  - Observatories, experiments, conference deadlines…
- Multiple providers
  - Not enough cycles, but also **risk-mitigation**
- From the de
  - Escal
    resou
- Ease of use/low
  - Automated
- From one-offs to production runs
  - Steadily increasing in both size and buy-in

Spiral Innovation

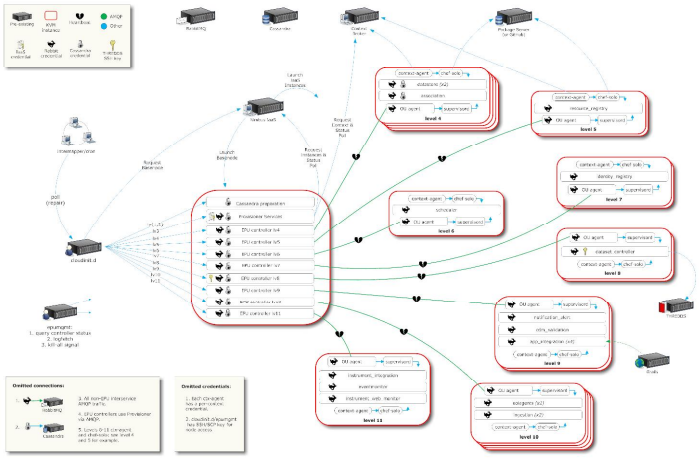
Building an Infrastructure Platform: Making Complexity Go Away

A Simplified Deployment Scenario



A Grid in Your Pocket…

Tim

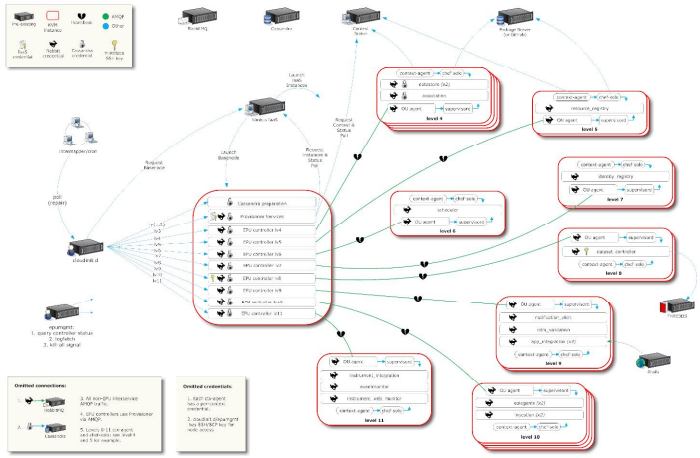


EC2

A Grid in Your Pocket…

Jamie

Tim



OOI private cloud

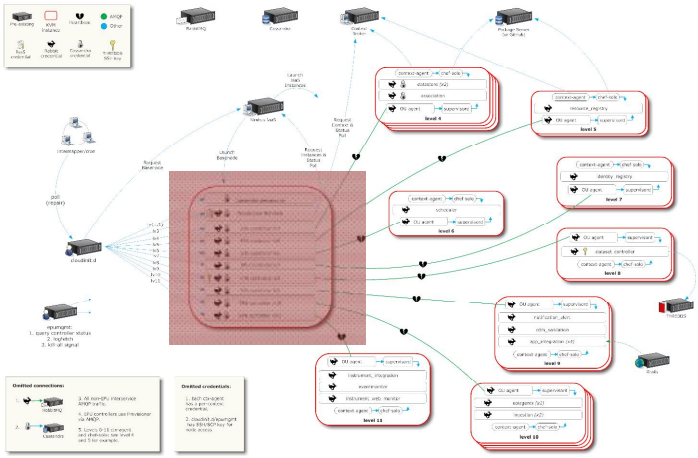
EC2

A Grid in Your Pocket…

David

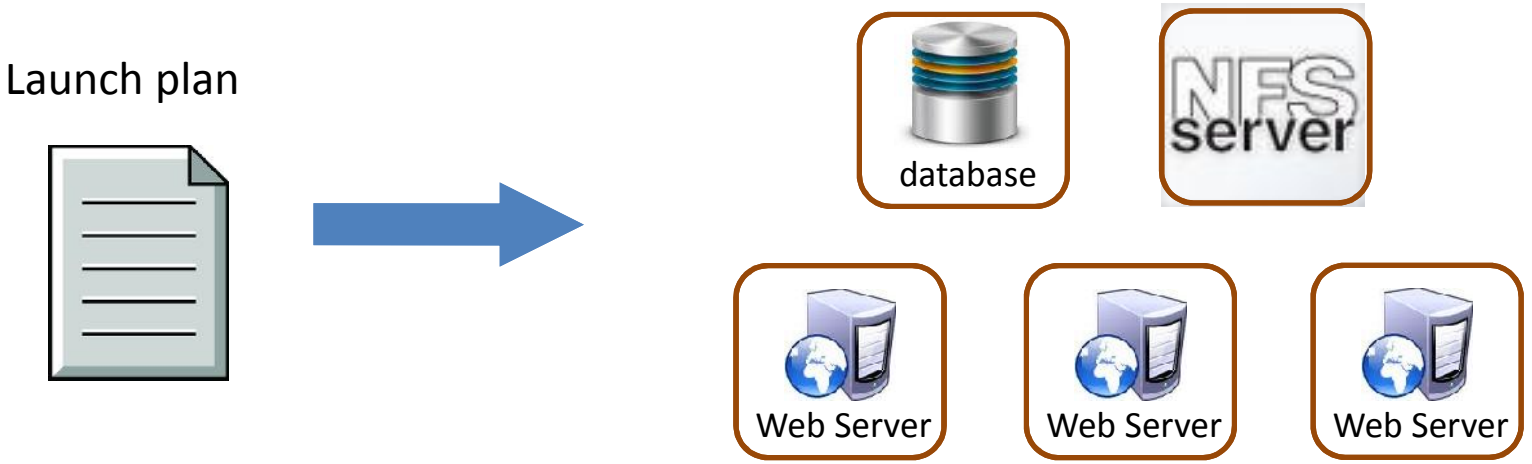
Jamie

Tim



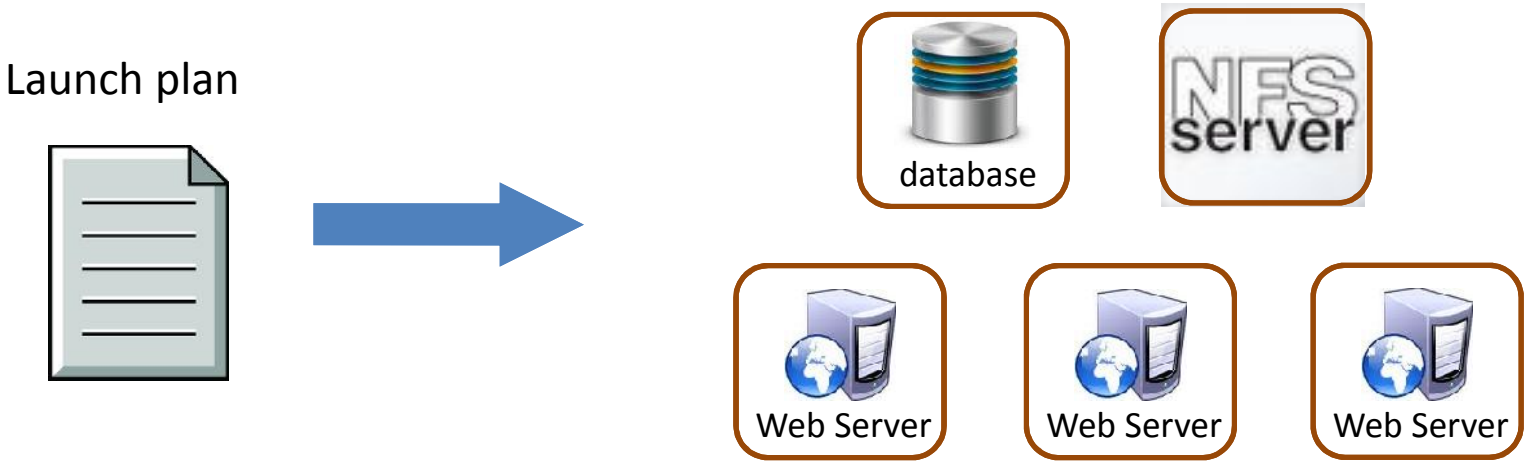
FutureGrid **OOI private cloud** **EC2**

Cloudinit.d Goals



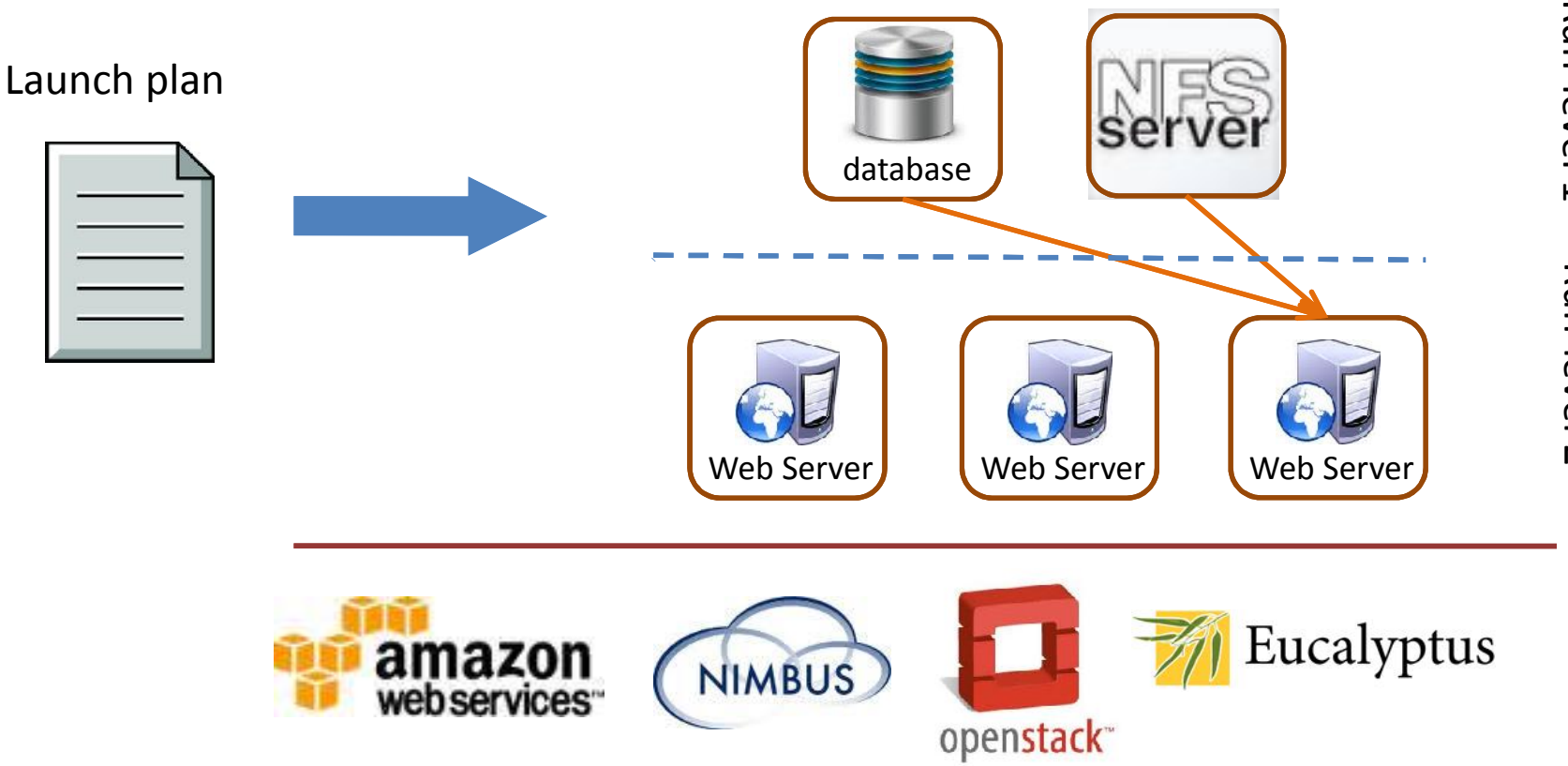
- Repeatability: write a launch plan once, deploy many times

Cloudinit.d Goals



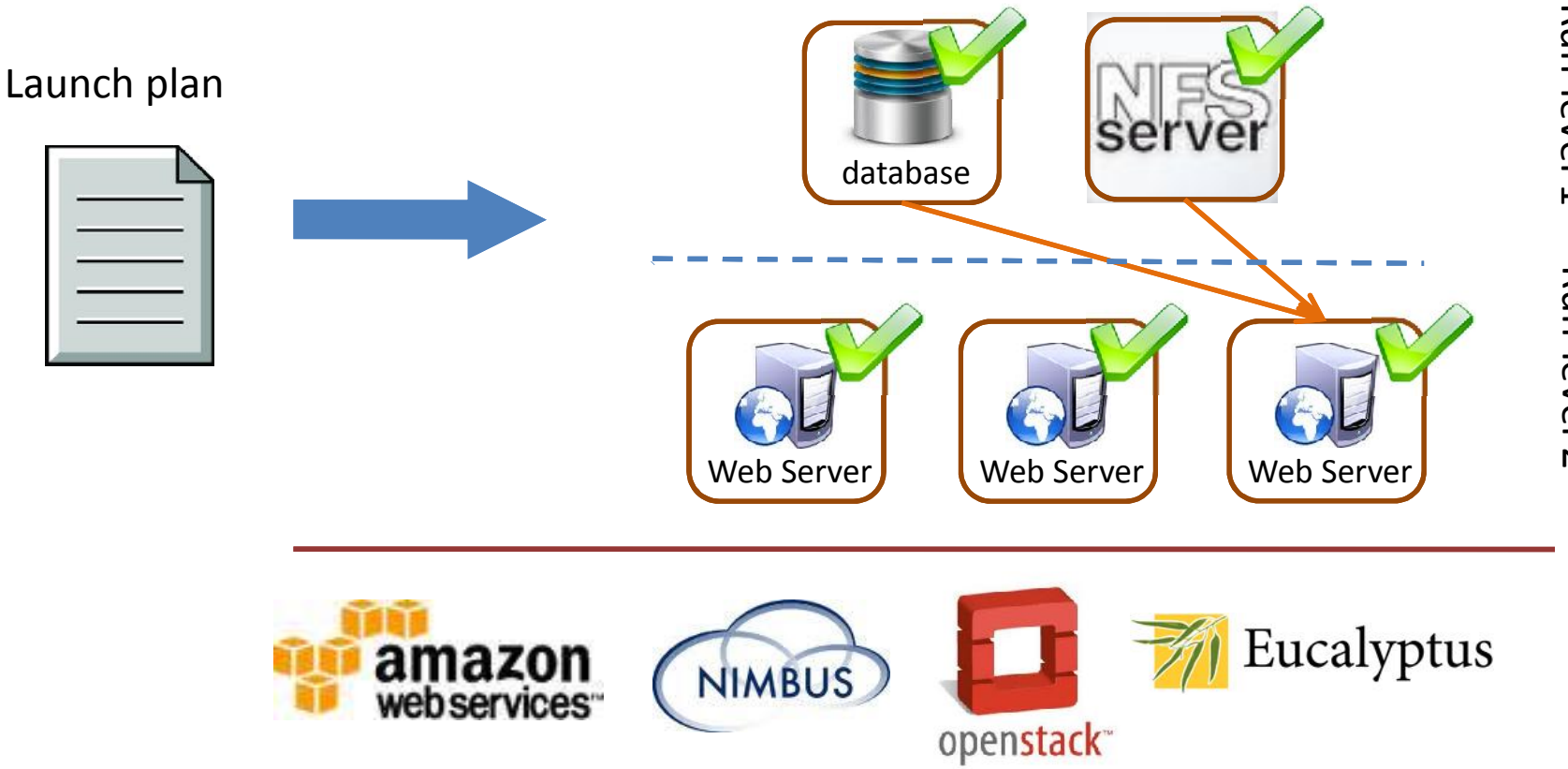
- Deploy on cloud and non-cloud resources from many providers

Cloudinit.d Goals



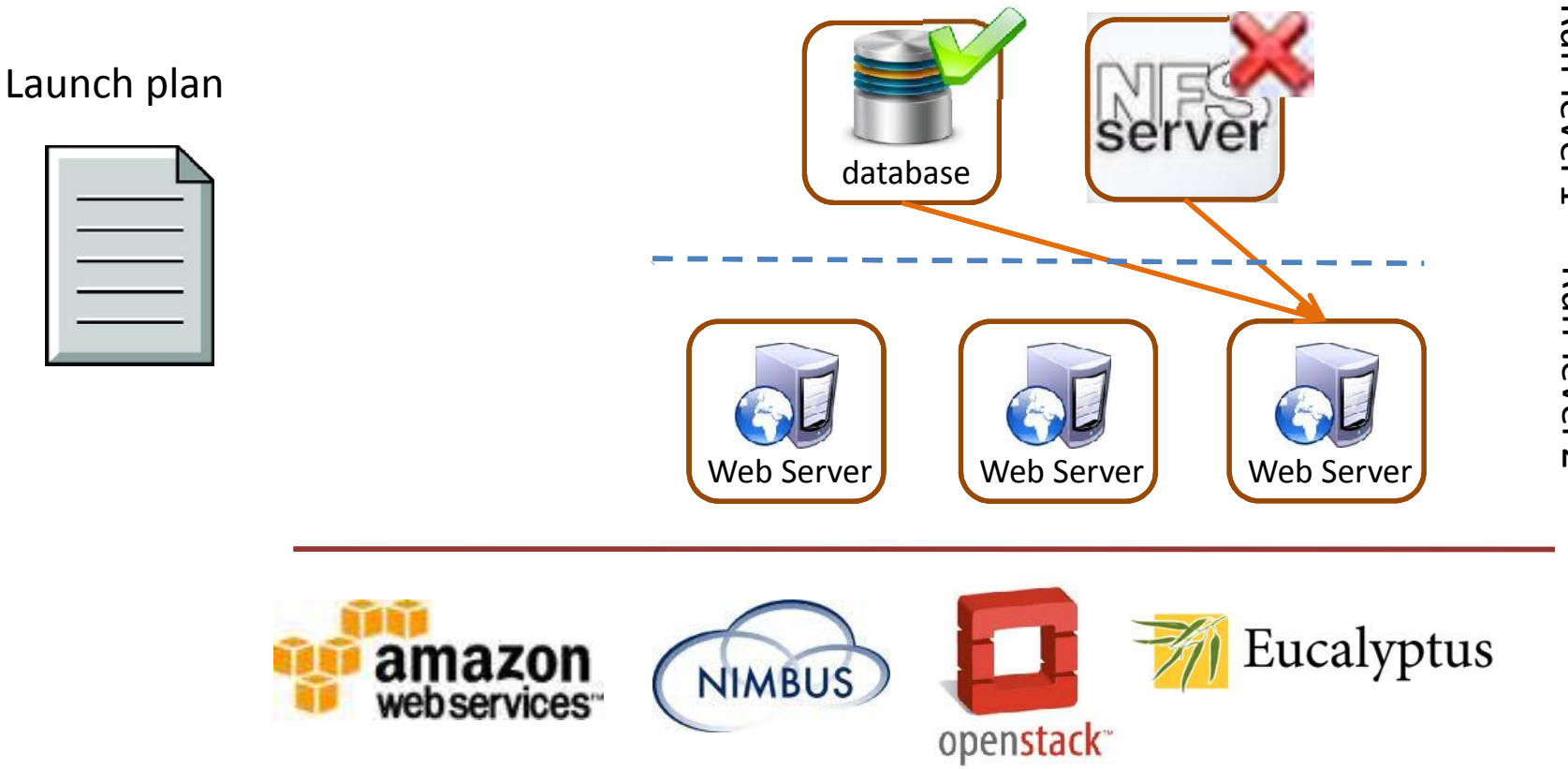
- Coordination of interdependent launches

Cloudinit.d Goals



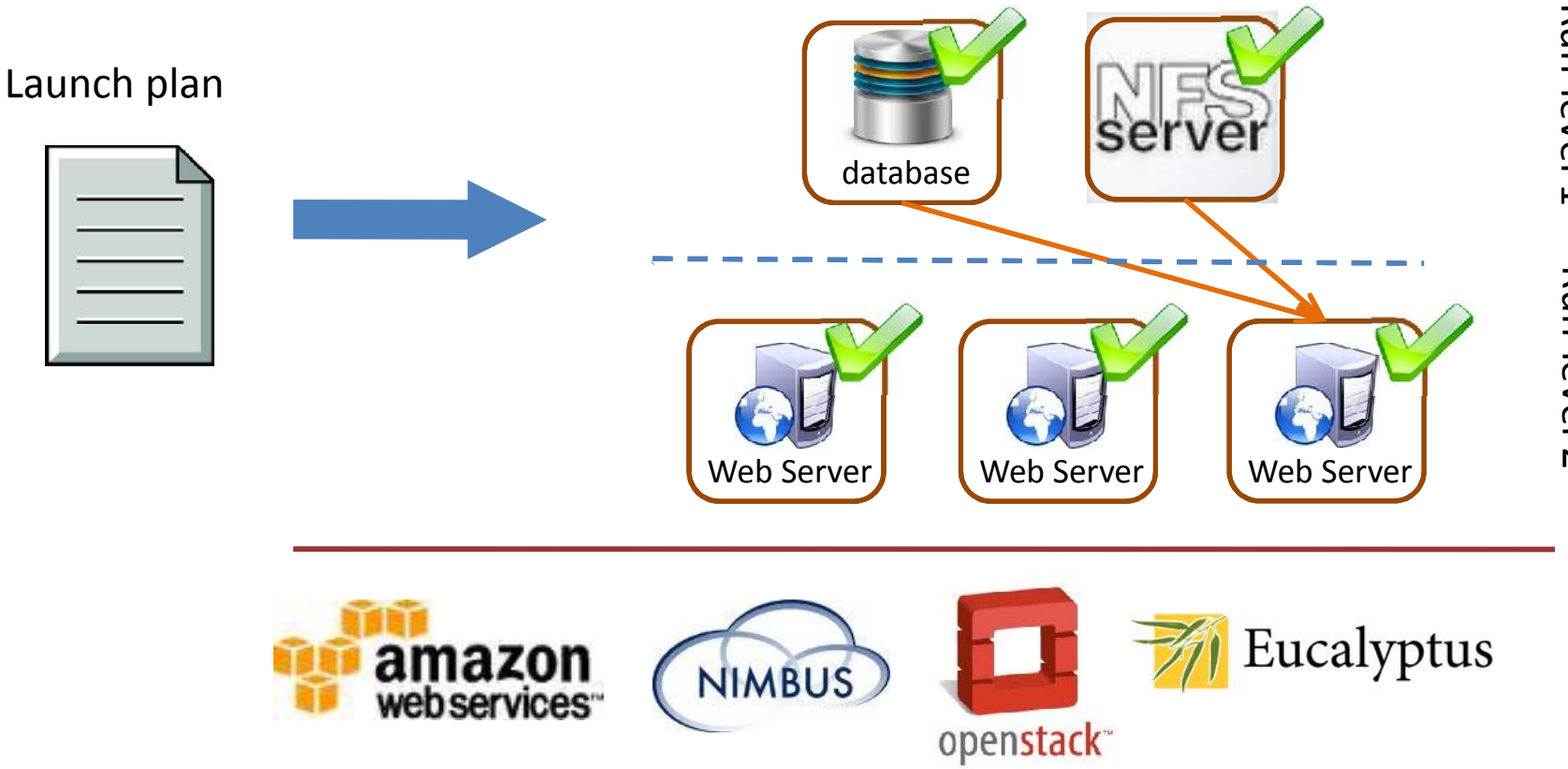
- User-defined launch tests

Cloudinit.d Goals



- Test-based monitoring and repair

Cloudinit.d Goals



- Test-based monitoring and repair

Cloudinit.d Goals: Easy to Use

- Two roles:
  - Launch plan developers and users
- Launch plan end-users/operators
  - Lightweight
  - Copy launch plan and “one click” action
- Launch plan/application developers:
  - Minimal software assumptions (ssh)
  - “Stem cell” deployment approach
  - Incremental launch plan development

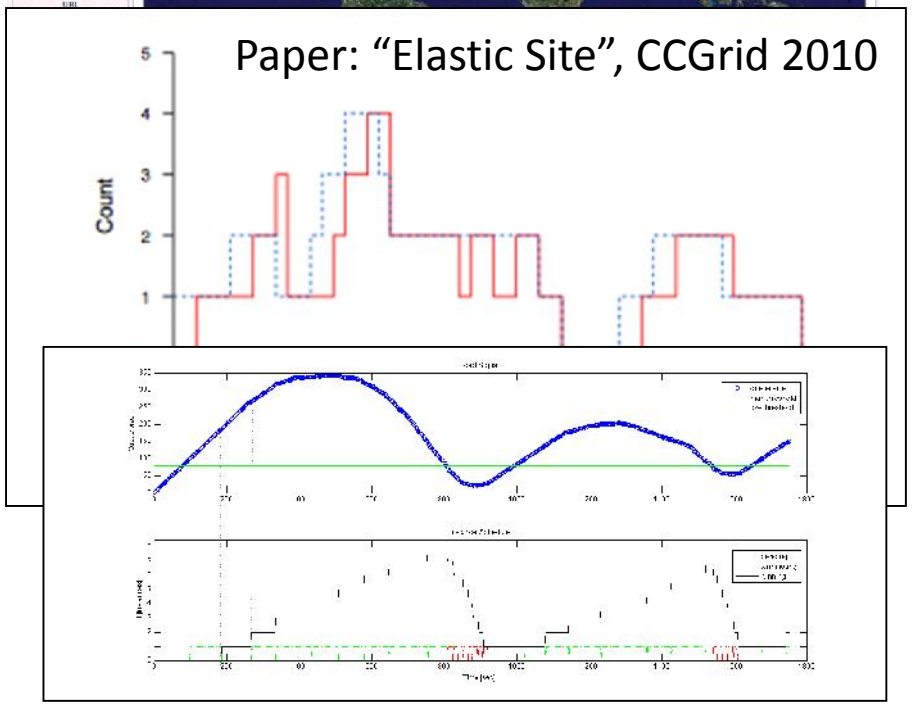
Building an Infrastructure Platform: Scale, Scale High, and Keep Scaling!

Prototypes

Elasticity and reliability are different sides of the same coin.

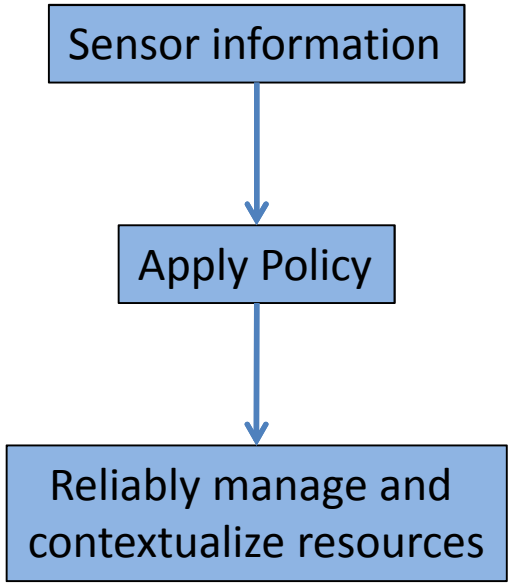
- 2008: The ALICE proof-of-concept
- 2009: ElasticSite prototype
- 2009: OOI pilot

Challenge:
a generic HA
elastic service model



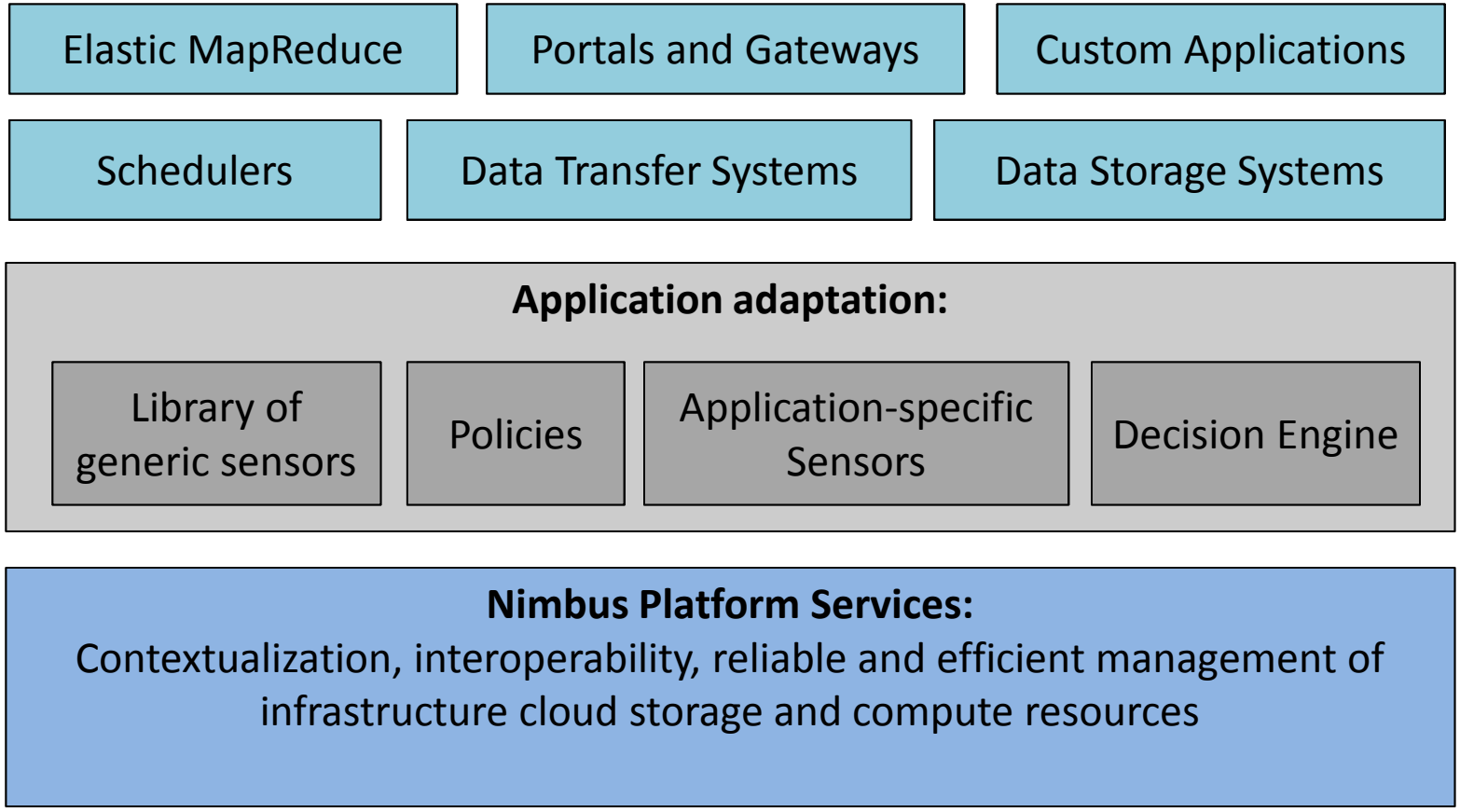
Patterns

- Monitor scaling factors:
  - A workload queue: ALiEn, PBS, AMQP,…
  - Application-specific qualities
  - Generic: deployment status, load, bank account, etc.
- Evaluate against policies
- Scale to demand
  - Across different cloud providers
  - Use contextualization to integrate machines across hybrid clouds
  - Address scientific needs for e.g., data transfer and storage
- Beta release later this year
  - Customizable to input, policy, decision engine, provider, etc.



amazon web services
NIMBUS
openstack
Eucalyptus

Applications



Parting Thoughts

- We used to provision over static resources
- Science has a naturally bursty character
- We can't have unlimited cycles…
- …but how they are provisioned should be driven by need rather than technology limitations
- Infrastructure clouds provide such mechanism – it is now a question of how to use it
- What would you do with dynamic resources?

"You've got to be thinking anyway, you might as well think big"

www.nimbusproject.com

Let's make cloud computing for science happen.